

TARO TRADE AND COST OF PRODUCTION IN SELECTED AREAS OF THE AMERICAN AFFILIATED PACIFIC

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Introduction

The common name taro is used to refer to *Colocasia*, *Xanthosoma*, *Cyrtosperma*, or *Alocasia*. All of these plants of the family Araceae provide important sources of food for many peoples of the world. The focus of this paper is on *Colocasia esculenta* var. *antiquorum*.

Taro is currently grown in nearly every tropical region of the world. World production of taro was estimated by the Food and Agriculture Organization of the United Nations (FAO) at over 12 billion pounds in 1988. A total of approximately 2.3 million acres were allocated to growth of taro worldwide. Leading producers on a worldwide basis as reported by FAO (1989) are: Nigeria, China, Ghana, and Japan with 33, 23, 12, and 7 percent of the total production. Many other nations produce taro, but as most taro is used for home consumption or other non-market purposes, accurate estimates of total production are difficult to verify.

Taro has been a staple crop for the inhabitants of the Pacific Islands for many years. Although Oceania only produces about 5.5 percent of the total taro produced worldwide, the crop is important for people in the region. Today, taro remains an integral part of the farming systems and diets of many people living on Pacific Islands. Table 1 provides estimates of annual taro production for selected areas of the Pacific.

Table 1. Estimated taro production in selected Pacific Island nations. (Source: FAO 1989)

Country	Production (1,000 lb)
Papua New Guinea	407.9
Western Samoa	88.2
Tonga	66.1
Solomon Islands	55.1
Fiji	26.5
American Samoa	8.8
Kiribati	6.6
New Caledonia	6.6
Wallis	4.4
Niue	2.2

In the tropics, staple food crops such as taro are often planted in small amounts on a continual basis. Large-scale production is not as common as planting smaller sections in intervals. One advantage of this method is it allows the grower to plant and harvest taro continuously throughout the year. Another reason growers are likely to plant small sections is that the cormels of harvested taro are often replanted soon after harvest. Although growers may obtain planting material from off-farm sources, it is more common for a grower to maintain his stock by replanting it immediately after harvest. This method spreads out the harvest of taro into smaller portions throughout a longer period.

Taro has a more flexible harvest timing than many other crops. Depending on the cultivars, it may be left in the ground for a period of time before harvest. This helps to assure the grower of having a steady supply for home consumption or other purposes throughout the year. Although taro may be stored for a short time after harvest, some cultivars keep well in the ground. The possibility of leaving taro in the ground until needed also serves as a means of storage in locations where electricity and refrigeration are not always available.

Much of the taro that is produced in the Pacific is not traded in the market, but rather it is used for other non-market purposes. It is important to remember that the motivations behind the production of this and other subsistence crops may extend beyond the purely quantitative economic (Bennett et al. 1983). Taro is used for home consumption, for social and cultural purposes, and it is sold in the market for income.

Taro carries different importance for the different peoples of the South Pacific. In Palau, for example, taro is sometimes referred to as the mother of life. It holds great value in the customs and social structure of the Palauan people. In American Samoa, there are social cultural purposes for which taro is grown. It is grown to share with friends and relatives, to give to local chiefs and pastors, and is an important food for Sunday feasts when family and friends come together. Other uses such as at traditional ceremonies, celebrations, holidays, and funerals are also important to the people of American Samoa. On

other islands in the Pacific the cultural aspects of taro are also strong.

Many of the ways in which taro is used, both formally and informally, occur outside of the market. Tables 2, 3, and 4 summarize the socio-economic aspects of the reports of the Rapid Rural Assessment (RRA) teams sent out by the LISA-taro project to American Samoa (AS), The Commonwealth of the Northern Mariana Islands (CNMI), the islands of Pohnpei, Yap Proper, and Ulithi Atoll in the Federated States of Micronesia (FSM), Guam, the island of Hawai'i and the Republic of Palau. The evaluations made in these tables should be considered subjective. They are the considered opinions of the authors and should not be taken as absolute.

The first column of Table 2 shows the principle uses of taro for the growers in each of these regions in the approximate order of importance. The second column attempts to evaluate the relative importance of taro in the diet in each area. The third column reports the sex of the

typical culturalist. The fourth column evaluates the importance of the cultural role of taro to the growers. The fifth column compares the dominant agricultural system used in the various areas, and the final column of Table 2 reports on the use of hired labor in the growing of taro.

Table 3 focuses on the agronomic practices reported by the RRA teams. The first column evaluates the level of marketing and indirectly the importance of the commercial aspects of production in each area. The final four columns of Table 3 report on the use of mechanization, commercial fertilizers, pesticides and herbicides respectively.

Table 4 summarizes the farm specific economic data assembled in this report. It provides farmgate prices, size of plantings, length of cultivation period, yield, revenue per acre, and total costs and returns where available. Further details are provided under each of the specific area discussions in the second part of this paper.

Table 2. A summary and comparison of the socio-cultural aspects of taro culture as reported by the RRA teams.

	Principal uses for growers ¹	Importance in general diet	Typical sex of culturalist	Cultural Role for most growers	Dominant cultural systems	Hired labor used?
American Samoa	S C M	Very	Both	Important	Dryland	Occasionally
Commonwealth of the Northern Mariana Islands	M C S	Minor	Male	Minor	Dryland	Yes
Federated States of Micronesia						
Pohnpei	S C M	Moderate	Female	Moderate	Dryland	No
Yap Proper	S C	Very	Female	Important	Dryland	No
Ulithi Atoll	S C	Very	Female	Important	Wetland	No
Guam	M C S	Minor	Male	Preservative	Dryland	Occasionally
Hawaii	M C ²	Minor	Male	Minor	Dryland Wetland	Yes
Palau	C S M	Very	Female	Very Important	Wetland Dryland	Rarely

¹ S=subsistence, C=cultural uses and M=market

² For Native Hawaiians, taro cultivation has important cultural preservation purposes.

Table 3. A summary of the agronomic practices used in growing taro as reported by the RRA teams.

	Degree of marketing	Degree of mechanization	Use of commercial fertilizers	Use of pesticides	Use of herbicides
American Samoa	Moderate	Moderate	5 %	27 %	50 %
Commonwealth of the Northern Mariana Islands	Heavy	Heavy	Rare	N.R.	N.R.
Federated States of Micronesia					
Pohnpei	Moderate	Light	42 %	11 %	0 %
Yap Proper	Rare	None	None	None	None
Ulithi Atoll	None	None	None	None	None
Guam	Mod.- heavy	Heavy	72 %	Light	Light
Hawaii	Heavy	Heavy	100 %	0 %	37 %
Palau	Light	None	Rare	None	None

Table 4. A summary of the economic aspects of taro culture in the areas under study.

	Farmgate price	typical size of planting	Length of culture period	Yield per acre	Sales per acre	Costs per acre	Returns per acre
American Samoa	.50 - .70	1/4 - 5 A	5 - 8 mo.	8,000	4,000	1,271	2,729
Commonwealth of the Northern Mariana Islands	.50 - 1.00	1 - 10 A	6 - 8 mo.	10,000	10,000	1,200	8,800
Federated States of Micronesia							
Pohnpei	.30	.05 A	4 - 8 mo.	7,744	3,175	2,651	523
Yap Proper	N.A.	N.A.	8 - 12 mo.	N.A.	N.A.	N.A.	N.A.
Ulithi Atoll	N.A.	.02 A	N.A.	N.A.	N.A.	N.A.	N.A.
Guam	1.50 - 1.99	.05 - 1 A	6 - 8 mo.	12,705	7,623	3,952	3,671
Hawaii	.30 - .50	3/4 - 6.5 A	7 - 10 mo.	30,000	11,750	8,020	3,730
Palau	.50 - .65	1/16 - 3/16	6 - 10 mo.	21,000	N.A.	N.A.	N.A.

Taro Production and Trade

The following area reports general economic factors which influence taro production in American Samoa, Pohnpei, Guam, the Commonwealth of the Northern Mariana Islands, and Hawai'i. Specific sections were not developed for Yap Proper, Ulithi Atoll, or for the Republic of Palau. Information about taro trade in each of these areas is included and is summarized in Table 5. Cost of production estimates were analyzed in a crop budget template which was designed at the University of Hawai'i.

American Samoa

General Information. American Samoa consists of seven islands in the South Pacific Ocean. Much of the terrain in the territory is steep hillside, limiting the growing of crops. Growers in American Samoa use many imaginative ways to grow crops, such as those which are described in *A Rapid Rural Appraisal of Taro Production Systems in Micronesia, Hawai'i and American Samoa* by Agnes Vargo and Lisa Ferentinos (1991) (RRA). In 1989 the estimated population of the territory was 38,200, up from 32,297 in 1980 and 27,364 in 1970. Population per acre in 1989 was approximately 0.78. The majority of the population live on the island of Tutuila.

It is estimated that at least one-third of the population of American Samoa today consists of those originally from Western Samoa. Eastern, or American Samoa, and what is now called Western Samoa have only recently been broken into two separate countries. They share the same ancestry and customs and similar methods of growing crops. The two groups of islands were divided in 1900 in a mutual agreement between the Germans, Americans, and the British, all of whom had interests in the area at the time. The islands east of the 171st meridian were designated as Eastern (American) Samoa and were designated as a United States territory.

Gross domestic product in 1985 was nearly 188 million dollars. In 1985, per capita gross domestic product was estimated at \$5,282. In 1985, the unemployment rate on the main island of Tutuila was estimated at 13.4 percent.

Major trade sectors according to the American Samoa Statistical Handbook (EDPO 1989) are the government (public administration) and manufacturing (primarily the canned tuna industry) employing 34 and 30 percent of the total work force, respectively. In 1988, over \$350 million of tuna products were exported from the country. American Samoa provided an estimated 25 percent of the total United States tuna supply in 1985 (Bank of Hawai'i 1988). During the same year, 1.2 percent of the work force was reportedly involved in agriculture, forestry, and

fisheries related occupations (EDPO 1989). About 80 percent of the fruits and vegetables consumed in the territory are imported, primarily from the West coast of the United States (Bank of Hawai'i 1988).

Total land size of the territory is estimated at about 48,749 acres. Of this total, an estimated 3.8 percent was utilized for subsistence and commercial farming in 1977. Average farm size in 1980 was 4.5 acres, down from 5.4 acres in 1970.

The traditional Samoan political systems of village chiefs, *matais*, remains strong in the territory. Most major decisions involving issues such as land use are made by local *matais*. This traditional system provides social structure and stability in American Samoa. The 1978 Census of Agriculture (EDPO 1979) reported that 891 farms were owned by those with *matai* titles while 373 farm owner were not *matai*.

Many crops in the territory are grown on a part-time basis by people who have other sources of income. Thus, much of the agriculture is carried out on a non-market basis, primarily to supply immediate consumption needs of family and custom.

Taro Production. In 1979, an estimated 971 farms were growing approximately 1,128 acres of taro. The RRA identified *Niue*, *Manua*, and *PaePae* as the major taro cultivars grown in American Samoa. There are also many other cultivars grown in varying amounts.

Major production constraints include land and labor availability. In 1969, an estimated 8,274,564 taro roots were harvested in the country. In 1978 the total was estimated at 1,807,059 (EDPO 1979).

The RRA concluded that weeds, taro planthopper, taro armyworm, and corm rot were major problems involved in growing taro during fall 1989. Most growers in American Samoa do not use large amounts of agri-chemicals on taro. Paraquat and Roundup are the most commonly used herbicides while Malathion is the most used pesticide. Farm machinery is not used as the steep terrain in most places will not allow for it.

Intercropping of taro has been the common practice for many years in Samoa. Currently, common choices for companion crops are: banana, coconut, giant taro (*Alocasia*), and papaya. Cropping time required from planting to harvest varies from six to eight months.

Taro is an important staple food in American Samoa. It is preferred by many Samoans to rice and bread even though it can be very costly. For example, in July 1990, taro was selling for an average retail price of \$0.84 per pound while rice was only \$0.25 per pound, indicating the popularity of taro among many Samoans. Taro is a mainstay of the large Sunday dinner and social time that

is an intrinsic part of the *Fa'a* (Samoan ways).

In 1987 the American Samoan Department of Agriculture reported that over 300,000 pounds of taro were sold at the central market place in Pago Pago. Some of this taro is grown locally, but much of it is shipped from Western to American Samoa. There are strong linkages between family and friends in these two groups of islands. In 1989, over four million pounds of taro were exported from Western Samoa to American Samoa. Most of this was transshipped to other countries such as New Zealand. The American Samoan Customs Department reports that the territory imported 423,000 pounds of taro in 1989.

Cost of Production. Typical cost of production for taro was estimated by Larry Hirata at the American Samoa Community College, Land Grant Program. The estimate was completed for the labor of a typical farm family. The labor of the father is paid \$2.50 per hour and is supplemented by labor of other family members whom are paid \$1.50 per hour. No land charge is included as most growers of taro in American Samoa use communal land. Also, planting material, or *tiapula*, are assumed to be obtained free of charge from family or friends.

Using a crop budget template designed at the University of Hawai'i, it was found that total variable costs accounted for about 62 percent of total costs for a typical farm operation growing taro. Labor costs amounted to 39 percent of the total costs with machinery and equipment, materials, and interest on operating expenses accounting for 11, 10, and 2 percent of total costs, respectively. Fixed costs which were accounted for were depreciation and maintenance of farm buildings, and the cost of auto insurance, electricity, and telephone service.

After a growing period of six months, an average yield was estimated at 8,000 pounds. Gross revenue was estimated at \$4,000 with a price of \$0.50 per pound. Returns to management were \$1,927 per acre, while returns to labor and management amounted to \$2,729. Based on total costs, break-even yield was 4,147 pounds while break-even price was \$0.26 per pound.

Pohnpei

General Information. The main island of Pohnpei is a roughly circular volcanic island lying about six degrees north of the equator. The capital of the Federated States of Micronesia is located in Palikir about five miles from Kolonia, the main town in Pohnpei. Pohnpei receives an average of approximately 190 inches of rain per year. The population was estimated at 33,969 in 1990 with 31,059 on the main island and 2,910 on the outer islands. The total population is up from 19,258 in 1973 and 22,081 in 1980. Population per acre calculates to about 0.40.

Gross state product in 1982 was estimated at 26 million using the expenditure approach. Pohnpei currently has a trade deficit with imports to exports in a 8.4 to 1 ratio. In 1985, food, beverages, and tobacco made up about 37.4 percent of total imports. Major agricultural exports in 1988 were trochus shells for a value of \$649,000 and black pepper and copra with values of \$316,000 and \$128,000, respectively. An estimated 35 percent of the population live in a self-reliant subsistence manner and are not included in the monetary economy. The 1987-1991 Pohnpei State Development Plan (PSG 1987) estimates the value of non-marketed household food as over 62 percent of the total value of food consumed in Pohnpei.

Much of the terrain in Pohnpei is steep with heavy forest areas. Shrestha (1990) has described the island as 60 percent mountainous with rolling hills, mangrove swamps, and coastal bottom lands consisting of 20, 16, and 5 percent of the total land area, respectively. Total land area is approximately 84,595 acres. The main island of Pohnpei makes up the majority of the land area. The outer islands make up only 2.4 percent of the total land area.

The U.S. Soil Conservation Service estimates that 57,682 acres or 68 percent of the total land is suitable for agricultural production. Land use in 1987 was described as 30 percent subsistence/tree crop, 4 percent specialty crops, and 64 percent woodland/mangrove swamp. The average farm size is estimated to be nine acres.

Taro Production. Before contact with European cultures, the culture in Pohnpei was characterized by excess production of agricultural crops. In this "prestige economy," taro was one of the important crops grown for local consumption. An FAO (1988) regional report states that approximately 25 to 30 percent of growers in Pohnpei grow some amount of taro.

In a survey done by Shrestha (1990), the number one production constraint taro growers identified was disease, primarily *Phytophthora*. Other major problems identified were pig and rat damage and difficulties in marketing taro. The major damaging insect is the planthopper followed by aphids and armyworms (*Spodoptera*).

The 1987-1991 Pohnpei State Development Plan (PSG 1987) reported that in 1980 taro production amounted to approximately 9.7 million pounds. During the same year, production of yams and breadfruit was 1.2 million pounds and 899,000 pounds, respectively. A recent FAO regional project estimated the production of taro as 226,000 pounds while production of yam was estimated at over 7 million pounds in 1987. An estimated 40 acres were dedicated to taro farming in 1988. Almost all taro or yam produced in Pohnpei is consumed locally, very little being exported.

Agri-chemicals are not yet commonly used in Pohnpei. The Division of Agriculture officially sold only \$1,100 worth of pesticides in 1988. There is a tractor rental service through the State Agriculture Division which is used by some growers. Tractors and implements for plowing can be rented for around \$10 per hour, and bulldozers are reported to be available for about \$25 per hour.

Shifting cultivation is the primary system of agriculture in Pohnpei. Most growers are using multicrop systems. Taro is often the first crop to be grown after clearing a new area of land. Taro is also often grown around individual homes. As reported by the RRA, some of the popular crops to intercrop with taro in Pohnpei are breadfruit, banana, papaya, *ylang ylang*, pineapple, sugarcane, yam, black pepper, and coconut. Some taro is grown in monocrop situations and is often rotated with sweet potato, cassava, *Xanthosoma*, and vegetables.

Taro plant spacing in the field varies from two-foot rows with two feet between plants (10,890 plants/acre) to three-foot rows with three (4,785) or four (3,625) feet between plants. The taro cropping cycle varies from four to eight months depending on the site and type of taro grown. Shrestha (1990) reports an average yield of three pounds per plant, although corms of over ten pounds have been harvested.

The RRA found that taro ranks behind rice, breadfruit, and yams as a staple food in Pohnpei. However, according to Shrestha (1990), the majority of yam production goes back into the soil in order to grow larger yams to maximize status. This means that taro may actually take on more importance as a regular source of food. Little of the taro that is produced is sold in the market. Most is consumed by those who grow it or is traded with family and friends.

Average farm gate price for taro that is sold ranges from \$0.15 to \$0.40 per pound. Market prices for the majority of taro range from \$0.25 to \$0.60 per pound. The popular *Sawa toantoal* (black taro) usually commands a higher price of \$0.40 to \$0.60 per pound at market. From 1985 to 1987, only 1,160 pounds of taro were reported to be exported from Pohnpei. Taro and other root crops are also used for animal feed.

Cost of Production. Information on the cost of production of taro in Pohnpei was provided by Bill Raynor. All costs which were accounted for were variable costs. Fixed costs such as land use, buildings, farm overhead, and those involved with owning and maintaining farm machinery were not included. Costs of renting equipment for dozing and plowing land were included. Labor was available for \$1.50 per hour. The activities

requiring the largest amount of labor were harvesting, fertilizing, and pest control. Also, plant nets were obtained at a cost of \$0.10 each. This was the largest material cost. Overall, materials including plant nets, fertilizer, pesticides, and contingencies, amounted to 55 percent of total costs, with labor at 45 percent making up the remainder.

An average yield was estimated at 7,744 pounds per acre. At a price of \$0.41 per pound, gross revenue was estimated at \$3,175 per acre. With total production costs at \$2,661 per acre, return to management was estimated at only \$514 per acre. Break-even yield based on total costs is 6,467 pounds, while break even price is \$0.34 per pound.

Guam

General Information. Guam, an unincorporated territory of the United States, lies at about 13 degrees north latitude. This territory is the center of communication and transportation for much of Micronesia. The population of Guam in 1990 was estimated at 133,152, up from 105,979 in 1980 and 84,996 in 1970. United States military personnel and their dependents made up about 19 percent of the total population in 1988. The population is estimated as 42 percent Chamorro, 24 percent Caucasian, and 21 percent Filipino. The remainder are of other Asian or Micronesian descent.

Gross domestic product for Guam in 1986 was over 1.6 billion dollars. The ratio of the value of imports to exports was approximately 14 to 1 during the first six months of 1984. Per capita gross domestic product stood at approximately \$8,562.

Tourism is the leading industry in Guam and has been the driving force behind recent economic growth in Guam. In 1988, over 470,000 visitors arriving in Guam declared their visit to be for the purpose of pleasure, up from a total of 173,000 in 1979. Nearly 86 percent of all visitors to Guam in 1988 arrived from Japan (ERC 1988). Tourism expenditures in the territory were estimated at over 450 million dollars in 1988, up from 314 million in 1983.

The total land area of Guam is approximately 135,680 acres. Southern Guam contains volcanic hills reaching heights of up to 1,300 feet while the northern part of the island is primarily a limestone plateau. At least ten percent of the total land base in Guam has been evaluated as having excellent potential for growing crops and another 25 percent for pasture and range land.

The agricultural sector in Guam contributed about \$7 million, or less than one percent of total GDP of the economy of Guam in 1986. Total production of fruits and

vegetables for 1988 was estimated at about 7.9 million pounds on 552 acres, up from 6.6 million pounds on 500 acres in 1983. Total sales of fruits and vegetables in 1988 were estimated at 6.3 million pounds with the difference being home consumption, wastage, gifts, etc. In 1983, about 19 percent of the value of Guam's consumption of fruits and vegetables was satisfied by local production while 81 percent was imported.

In 1987, farmers themselves sold about 67 percent of locally grown fruits and vegetables. Other outlets such as retail stores and military outlets made up 31 and 2 percent of the total value sold, respectively.

The Department of Commerce in Guam reported that in 1982 approximately 26.7 thousand acres were utilized for agriculture in Guam. This compares to an estimated 64.9 thousand acres used for the same purpose in 1940. Land availability is not a major constraint to greater agricultural production on Guam. Land ownership is estimated at 43 percent private with 25 and 32 percent owned by the Government of Guam and the United States Federal Government, respectively.

Before the second World War most of the people of Guam were involved in subsistence agriculture. The war created many jobs for the people of Guam in association with the United States military presence, especially in the service sector. The Vietnam War fostered more of this type of employment.

The unemployment rate in Guam is reported to be very low, between two and three percent. It is relatively difficult to find willing farm workers. This fact is evidenced by the large proportion of foreign farm workers to local workers in Guam. The minimum wage rate in Guam in 1986 was \$3.35 per hour. Manner reports that the going rate for hired help can be as high as fifty dollars per day and even at that price can be hard to find.

In 1982, there were approximately 107 paid farm workers in Guam compared to at least 3,128 unpaid workers who were working mostly for relatives. Guam Department of Agriculture identified 145 farmers on Guam in 1988. During the same year, the number of subsistence growers was estimated at 772. There are many part-time farmers who plant crops on an occasional basis to supplement their income (EDPD 1989). Those employed full time in the agriculture industry were estimated at 0.3 percent of the total work force of Guam in 1988.

Taro Production. The Department of Agriculture in Guam estimated that during 1988 about 31,448 pounds of taro and leaves were produced on 14.6 acres in Guam. This compares to 23,040 pounds on 12.8 acres in 1983.

Taro and sweet potatoes are the most important locally grown starches in Guam. Bread, rice, potatoes, and

noodles are also consumed in large quantities but are all imported.

Taro is an important cultural crop to many farmers in Guam. Much of the taro is produced for family use only. It is an important part of many social functions of the indigenous Chamorro people. In a sense, taro's importance as a crop stems from the desire for the farmers and the Chamorro population in general to preserve their culture. In order for a social function to be authentic, it must provide indigenous foods, and taro is one of the foods that should be served. Several of the commercial farmers interviewed by the RRA team indicated that only 50 percent was going to market because of social and family obligations to provide for these social functions.

Planting taro in Guam is mostly done by hand, although mechanical planting has been used in some cases. A common plant spacing is 3 by 3 feet, yielding 4,785 plants per acre. The cropping cycle for taro is variable but usually ranges from six to eight months.

The dry season in Guam usually occurs from January to June. Taro is most often planted after this dry season and harvest is often planned to correspond with the Christmas season. Fertilizers are used in a non-intensive way, usually some formulation of N-P-K is applied during the first three months of growth. The use of other agri-chemicals is on an irregular basis. Cultivation is often done by rototiller or tractor between rows and by hand between plants. Drip irrigation is sometimes used in Guam, especially during the dry season.

Farm prices for taro have been reported as high as \$2.00 per pound in Guam. Manner (pers. comm.) reports average retail prices for red and white taro in 1989 as \$1.96 and \$1.84, respectively. Farm gate prices ranged from \$1.08 to \$2.00, depending largely on quality.

Imports of taro to Guam amount to approximately 20,000 pounds. Taro has been imported in the past from Taiwan and Hawai'i, but prices are generally too high to merit a large trade in this direction. Currently most imports are from the CNMI and the FSM.

Artero (1989) estimates that 10 to 20 percent of fruit and vegetable production is not marketed but is used for personal consumption, gifts, and spoilage. Manner (pers. comm.) reports that even on commercial-oriented farms a large amount of taro production is used for consumption on the farm or given away to relatives and friends. The RRA found that even if not profitable, taro would still be grown because of its cultural importance.

Cost of Production. Costs of production of taro on Guam were developed from information provided by Joe Cruz of the Agricultural Experiment Station and Frank

Cruz of the Cooperative Extension Service. In-depth interviews were also conducted with three commercial farmers. Overall farm size was assumed to be three acres. Farm labor was charged at \$7.00 per hour. Farm equipment consisted of a 4 x 4 pickup truck (half of whose costs were charged to the farm), a tractor valued at \$25,000, and a plow, mower, disk, and rotovator. Land rent was estimated at \$500 per acre per year. Planting material was assumed to be maintained by the farmer at no additional cost.

Variable costs were \$2,133 and fixed costs were \$2,598, giving a total cost of \$4,731. This is the second highest cost of the five areas studied. Revenue is \$10,604 based on a yield of 7,779 pounds per acre, giving the highest returns to management of any of the five areas studied at \$5,873 per acre. Of the variable costs, labor was the largest component at \$1,512, or 32 percent of total costs. Break-even yield was 3,478 pounds and break-even price was \$0.61 per pound.

Commonwealth of the Northern Mariana Islands

General Information. The Commonwealth of the Northern Mariana Islands (CNMI), consists of 16 islands in a chain running north to south between 14 and 20.5 degrees north latitude. Guam, although not included in the CNMI, geographically falls into this group of the Mariana Islands at the far southern end. Several of the northern outer islands are now, or in the last 100 years have been, active volcanoes.

Total population of the commonwealth was 16,780 in 1980 compared to 23,258 in 1989. In 1989, Saipan was the most populated island in the CNMI group with 86.7 percent of the total population followed by Rota, Tinian, and other outer islands with 7.8, 5.4, and less than 1 percent of the population, respectively.

In addition to this population of residents, there is also a large non-resident population in CNMI. The population is estimated to be made up of about equal parts of residents and non-residents. The non-resident population in 1988 was made up predominantly of Filipinos. In 1986, only about 4.25 percent of the total work permits that non-residents are required to obtain were for those working in the agriculture, forestry, and fisheries sector. Bank of Hawai'i (1988) reports that in 1986 about 70 percent of the total work force was made up of foreigners. The minimum wage as reported by Stewart (1988) was about \$2.15 per hour.

The government sector, tourism, and garment manufacturing dominate the CNMI economy. Gross island product for 1987 was estimated at \$359 million. Per capita gross domestic product in 1988 was estimated at \$3,456. The island of Saipan has been experiencing more

rapid growth than Rota or Tinian. Japanese investment has played a large part in the recent economic growth of CNMI. Visitor entries in 1989 numbered just over 300,000. On any given day, there are an average of 2,200 to 2,800 tourists in the country, predominantly Japanese.

Like many island economies, CNMI requires many imports and so accumulates merchandise trade deficits. Imports in 1988 totalled 219.6 million dollars and were mostly construction materials estimated at 41.7 million dollars followed by food and petroleum products at 29.7 and 28.5 million dollars, respectively. The ratio of inbound to outbound cargo on a weight basis in 1988 was about 7.5 to 1.

Total land area in CNMI is about 117,852 acres, of which the majority is the three major islands of Saipan, Rota, and Tinian. Saipan contains about 29,440 acres, of which about 2,407 acres are used as rangelands and 517 acres are cropland. Tinian consists of about 24,960 acres, of which an estimated 247 acres are in small, family-based agriculture. Commercial and subsistence agriculture take up another 148 and 49 acres, respectively. Approximately two-thirds of the island is used by the United States military. The island of Rota is about 21,056 acres, of which about 100 acres is used for commercial agriculture and another 50 acres for subsistence-based agriculture. Although more land area is used for commercial agriculture in Rota, about 50 of the total 75 growers there are operating on a subsistence basis. Another 20 growers operate on a mixed subsistence/commercial basis, and about five are reported to be entirely commercial. Major crops are sweet potato, banana, yam, and taro. Sweet potato is the most commonly grown crop.

Taro Production. There are several cultivars of *Colocasia* actively grown in CNMI. Red and Hawaiian taro are commonly grown cultivars. *Xanthosoma*, locally called 'Honolulu taro', is also fairly common. The RRA indicates that the growers choice of cultivar often depends on eating preference, prices, and market demand.

Taro is planted in monocrop and multicrop situations. Intercropping is done with a wide variety of other crops. Common planting distances range from three to six feet between rows and two to six feet between plants (1,152 to 7,161 plants per acre).

Although sprinkler and drip irrigation is used in the CNMI on some crops, it is not common for taro to be irrigated. The rainy season in CNMI usually occurs from July to October.

Ragus (pers. comm.) estimated current taro production at about 70,000 pieces per year on Rota. Production is highest at the end of the year, corresponding with the holiday season. An estimated 24 acres of taro are grown

on Rota, of which 70 percent is commercially produced. Taro is usually harvested after six to eight months of growth. About 90 percent of taro production on Rota is exported to Saipan and Guam. The remaining ten percent is consumed on Rota. About 40 percent of this taro is traded or given to friends and family in Guam and Saipan while the rest moves through the wholesale channels. Tinian also occasionally ships taro to these destinations. The two major retail markets for taro and other fresh produce in Saipan are the Saipan Farmer's Market and Garapan Produce Center.

Average wholesale price for taro on Rota is reported to be about \$1.00 per pound. Average wholesale prices for red taro on Tinian are also reported at about \$1.00 per pound. On Saipan, Red and Japan taro is usually sold for \$1.00 wholesale and \$1.50 per pound retail. *Xanthosoma* on Saipan is a little cheaper at \$0.50 to \$0.60 per pound wholesale and \$0.99 per pound retail.

Cost of Production. Lolita Ragus (pers. comm.) provided an estimate of a typical cost of production scenario to taro production in CNMI. Overall farm size was assumed to be five acres. A nominal two dollars per acre charge for land use was included. Skilled labor was charged at \$4.00 per hour, while unskilled labor was charged at \$1.25 per hour. A 4 x 4 pickup truck was assumed to be maintained by the farmer, and one-half of its costs were charged to farm overheads. Equipment included a tractor at a cost of \$35,000. Planting sets (7,500 per acre) were assumed to be purchased at a price of \$0.01 each.

Total costs were estimated at \$1,825 per acre. Yields were estimated at 3,662 pounds per acre with gross revenue of \$3,662 at a price of \$1.00 per pound. No particular variable cost stood out. Labor, machinery, and material all ranged from 11 to 16 percent of total cost. Fixed and variable components of the machinery cost would have been substantially lower as would have total cost if the farm was assumed to have taken advantage of the governmental rental program available. Return to management was the lowest of the five areas studied at \$1,836 per acre. Break-even yield and price were 1,825 pounds and \$0.50 per pound, respectively.

Shipping costs to Guam and Saipan from Rota range from \$0.06 to \$0.18 per pound by air or about \$0.03 per pound by boat, with minimum quantities of 1,000 pounds. From Tinian and Saipan, shipping costs are reportedly about \$0.10 per pound by air.

Hawai'i

General Information. The islands of Hawai'i lie about 2,400 miles southwest of San Francisco in the North

Pacific Ocean. The islands consist of the tops of a long chain of submerged volcanic mountains. The islands, which officially became a part of the United States in 1959, today have an estimated population of just over 1.1 million. Population in 1970 was about 770,000 and in 1980, 964,000. An estimated three quarters of the population live on the island of Oahu, the majority in the capital city of Honolulu. About ten percent of the population are members of the United States military. Total land area is around 6,540 square miles and population per square mile is around 170, or .27 per acre.

Gross state product in 1989 was nearly 24 billion dollars, about twice the figure for 1980, both in current dollars. Per capita gross state product was estimated at \$21,500 in 1989.

Along with the military sector, tourism is a major industry in Hawai'i. Nearly seven million people visited the islands of Hawai'i during 1989. Of this total, an estimated 61 percent are from other states in the U.S., 19 percent are from Japan, and the remainder arrive from other points of origin.

Agriculture made up approximately three percent of the total gross state product in 1989. Crop sales were estimated at \$485 million. Sugarcane and pineapple remain as the most important crops in state, although factors such as rising input costs and foreign competition have encouraged growers in Hawai'i to diversify into other crops. Sugar products made up about 36 percent of total crop sales in 1989, while pineapple accounted for around 17 percent, and other diversified crops completed the total. Acreage in sugarcane decreased from an estimated 218,000 in 1980 to around 171,000 in 1989. Other major agricultural commodities in Hawai'i in 1989 were macadamia nuts, potted foliage plants, papayas, and coffee.

Taro Production. Taro has been an important crop in Hawai'i since the first people came to the islands. This crop was carried to the islands by its first inhabitants to be grown as a staple food crop. Although taro is often prepared by boiling and baking, mashed forms of taro such as *poi* and *kulolo* are also popular. Also, taro is made into chips for the snack food market.

Taro production in Hawai'i has decreased from about 10.2 million pounds in 1959 to approximately 6.5 million pounds in 1989 (Hawai'i Agricultural Statistics Service 1990). About 64 percent of the taro grown statewide was on Kaua'i, while the Big Island produced around 25 percent, with the remainder on the other islands. The total value of taro in the state in 1989 was estimated at just under \$2 million. The majority of the estimated 150 taro farms in the state are located on the Big Island and on Kaua'i. The Big Island tends to be the center for

Chinese taro production grown in dryland conditions, while much of the taro grown in wetland conditions for *poi* manufacturing is on Kaua'i. Average farm price for *poi* taro was estimated at about \$0.29 per pound while Chinese taro received an average of \$0.40 per pound in 1989.

Some taro is imported to Hawai'i from other islands in the Pacific. In 1985, an unusually large amount of one million pounds of taro was imported, while in 1989 imports amounted to about 729,000 pounds. Hollyer et al. (1990) report that most of the taro imported in 1988 was from the Samoas to be consumed as table taro.

Some Chinese taro is also shipped from Hawai'i to the West Coast. Taro from Hawai'i is reported to have a quality advantages over taro shipped to the West Coast from other locations. However, Hollyer et al. (1990) point out that supply from Hawai'i is currently inconsistent and the price of Hawaiian taro tends to be higher than that of the competition.

Among major concerns of taro growers in 1990 were: weed and insect control; high labor costs and low labor availability, which motivate interest in farm mechanization; the need to preserve and learn more about the attributes of different taro varieties; and for wetland taro, the distribution and control of water supplies.

The RRA identified three general types of taro cultivation currently employed in Hawai'i: wetland or *lo'i* production, high-input dryland production characterized by commercial monocrop production with various purchased off-farm inputs, and low-input dryland production featuring multicropping with fewer off-farm inputs. Ginger is often rotated with taro in monocrop situations while common companion crops with taro in low-input systems were banana, coffee, and *ti*.

Cost of Production. Cost of production information was completed for dryland taro grown on the Big Island. Dwight Sato set up four cost of production situations for Chinese taro which were run through the crop budget template. The four scenarios were for a typical, or base case cost-of-production, situation; a case in which planting materials were obtained at no charge; an optimal situation with higher yields; and a situation where yields and prices were set at lower, more conservative levels.

In the first scenario, the base case, a typical cost-of-production situation was set up. In this base case, planting sets or *hulis*, needed to be purchased at \$0.10 per piece. Unskilled labor was obtained at \$4.50 per hour while skilled labor was valued at \$8.00 per hour. Fixed costs for land use, machinery and equipment ownership cost, and building maintenance and depreciation were included. For the base case, fixed costs amounted to 21 percent of total costs, at \$1,573 dollars.

Labor was the largest variable cost accounting for over half of the total variable costs. Expenses on machinery and equipment and materials made up the remaining variable costs. Variable machinery costs accrued mostly during land preparation and harvesting activities. The major material expense was for *hulis* or planting sets. Materials needed for maintenance such as fertilizer and pesticides and those for harvesting such as bags, racks, and water made up most of the remainder of the variable material expenses. Interest on operating expenses was deducted from gross revenue for all four Hawai'i scenarios using an interest rate of 12 percent. Overall, variable costs of labor, materials, machinery and equipment, and interest on operating expenses made up 40, 24, 8, and 7 percent of total costs, respectively, in the base case.

A yield of 25,000 pounds of Grade A and 5,000 pounds of lower-grade taro per acre was assumed. Grade A received a price of \$0.40 per pound, while lower-grade taro earned \$0.35 per pound. Total gross revenue was \$11,750 per acre. With total costs estimated at \$8,020 per acre, return to management was \$3,730 per acre. Break-even yield and price based on total costs were 20,476 pounds and \$0.27 per pound, respectively.

A second cost of production situation was set up in which planting material was obtained at no charge. This was a large change since *hulis* were the largest material expense in the base case. All of the other calculations used in the base case remained the same. With the change of planting material costs, total material costs decreased from 24 to 10 percent of total costs. Total costs decreased from \$8,020 to \$6,663 per acre. Return to management went from \$3,730 to \$5,087 per acre. Break-even yield and price were 17,012 pounds and \$0.22 per pound, respectively, based on total costs.

A third, optimal situation was set up in which *hulis* were paid for at \$0.10 a piece and yields increased to 35,000 pounds of Grade A taro and 5,000 pounds of off-grade taro which received the same prices of \$0.40 to \$0.35, respectively. All costs remained the same as in the base case except those for fertilizer and harvesting labor and materials. These cost were increased for this case of higher yields. With these higher costs, variable costs increased to \$8,292 per acre, boosting total costs to \$9,031. Gross revenue calculated to \$15,750 so that return to management in the high-yield case was estimated at \$6,719 per acre.

A fourth scenario was calculated using the same costs as the base case but with more conservative estimates of yields and prices of harvested taro. In this case, it was assumed that the 20,000 pounds harvested for the fresh market paid \$0.40 and \$0.30 cents per pound, respectively.

Gross revenues in this case were \$9,500 per pound so that return to management was \$1,480 per acre. In order to break even, an average price of \$0.32 per pound or a yield of 21,105 pounds would be needed.

Summary

The rapid rural assessments provide a look at taro on islands that are in many different stages of economic development and of cultural intrusion. Generally, as an island developed economically and cultural intrusion

increased, taro became less important in the diet and imported starches such as rice became more important. Farmers' motivations for growing taro change from socio-cultural and subsistence to commercial, and with this change the use of mechanical equipment and fertilizers increased.

Taro remains a viable and important crop in all of the areas studied with the possible exception of Guam. On Guam, the combination of labor shortages and the fact that taro takes several months to grow exposing it to a larger risk to loss from tropical cyclones than shorter period crops has decreased severely the amount grown over the last several years.

Table 5. Taro trade information about American Samoa (AS), the Commonwealth of the Northern Mariana Islands (CNMI), Guam, Hawai'i, and Pohnpei.

	AS	CNMI	Guam	Hawaii	Pohnpei
YIELD	8,000	3,662	7,779	30,000	7,744
PRICE	0.50	1.00	1.36	0.39	0.41
GROSS SALES	4,000	3,662	10,604	11,750	3,175
FIXED COSTS					
Land	N.A.	2	525	424	N.A.
Buildings	321	50	83	72	N.A.
Machinery	149	401	542	777	N.A.
Overheads	413	557	1,448	300	N.A.
Sub-total	793	1,010	2,598	1,573	N.A.
VARIABLE COSTS					
Land prep.	317	161	225	645	180
Planting		122	420	1,690	574
Weeding/hilling	48	239	367	916	240
Fertilizing	102	0	216	a	607
Pest control	282	88	36	a	401
Harvesting	75	134	560	2,663	300
Marketing	415	20	175	a	25
Interest	45	51	133	532	334 b
Sub-total	1,281	816	2,133	6,447	2,661
TOTAL COSTS	2,074	1,826	4,731	8,020	2,661
RETURNS	1,927	1,836	5,873	3,730	514

a included above. b includes \$248 for contingencies.

Table 6. General taro production and trade data for the areas under study.

	Total acres of taro	Commercial production	Total production	Imports	Exports
American Samoa 27 %	1,128	N.A.	1,807,059 (corms)	423,000	N.A.
Commonwealth of the Northern Mariana Islands	73	389,000	546,000	N.A.	143,000
Federated States of Micronesia					
Pohnpei	40	N.A.	9,700,000 ¹	N.A.	1,160 (85,86 & 87)
Guam	14.6	15,724	31,448	20,000	N.A.
Hawaii	430	6,500,000	6,500,000	729,000	N.A.

¹ This figure may be a considerable over-estimate (Raynor per. com.).

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